GARY BISHOP

Experience

University of North Carolina at Chapel Hill.
Associate Professor, January 1997-
Research Associate Professor, May 1991-December 1996
Adjunct Associate Professor, June 1988-April 1991

Sun Microsystems, Research Triangle Park, NC.
Senior Staff Engineer, January 1988-May 1991.

AT&T Bell Laboratories, Holmdel, NJ.
Member Technical Staff, June 1984-January 1988.

Education

Ph.D., University of North Carolina at Chapel Hill, Computer Science, 1984; thesis advisor, Henry Fuchs

BEET, Southern Technical Institute, Marietta, GA., Electrical Engineering Technology, 1976

Selected Publications

Henry Fuchs, Mark Livingston, Gary Bishop, Greg Welch. 'Dynamic Generation of Imperceptible Structured Light for Tracking and Acquisition of Three Dimensional Scene Geometry and Surface Characteristics in Interactive Three Dimensional Computer Graphics Applications', patent number 5,820,136. 1999.

Greg Welch and Gary Bishop. 'SCAAT: Incremental Tracking with Incomplete Information', In Proceedings of Siggraph'97 (Los Angeles, CA, August 3-8 1997). In Computer Graphics Proceedings Annual Conference Series, ACM SIGGRAPH, pp. 333-344.

Ronald Azuma and Gary Bishop. 'A Frequency-Domain Analysis of Head-Motion Prediction', Proceedings of Siggraph'95 (Los Angeles, CA, August 6-11 1995). In Computer Graphics Proceedings, Annual Conference Series, ACM SIGGRAPH, pp. 401-408.

Marc Olano, Jon Cohen, Mark Mine, Gary Bishop, 'Combating Rendering Latency', 1995 Symposium on Interactive 3D Graphics (Monterey, CA, April 9-12, 1995). Special issue of Computer Graphics, ACM SIGGRAPH, New York, pp. 19-24.

Henry Fuchs, Gary Bishop, Kevin Arthur, Leonard McMillan, Ruzena Bajcsy, Sang Lee, Hany Farid, Takeo Kanade. 'Virtual Space Teleconferencing Using a Sea of Cameras', Proceedings of the First International Symposium on Medical Robotics and Computer Assisted Surgery, Vol. 2, Pittsburgh, PA, Sept. 22-24, 1994, pp. 161-167.

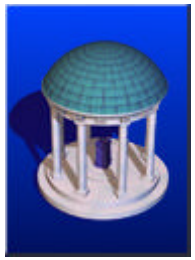
Ronald Azuma, Gary Bishop. 'Improving Static and Dynamic Registration in an Optical See-through HMD', Proceedings of Siggraph'94 (Orlando Florida, July 24-29, 1994). In Computer Graphics Proceedings, Annual Conference Series, 1994, ACM SIGGRAPH, pp. 197-204 + CD-ROM appendix.

Gary Bishop, Henry Fuchs, et. al. 'Research Directions in Virtual Environments', ACM Computer Graphics, vol. 26, no. 3, pp. 153-177. 1992.

Jih-Fang Wang, Ronald Azuma, Gary Bishop, Vern Chi, John Eyles, and Henry Fuchs. 'Tracking a head-mounted display in a room-sized environment with head-mounted cameras'. Proceeding: SPIE'90 Technical Symposium on Optical Engineering & Photonics in Aerospace Sensing. Orlando, FL. 1990, pp. 47-57.

Gary Bishop. 'The Self-Tracker: A Smart Optical Sensor on Silicon'. Ph.D. Dissertation, UNC-CH Computer Science. 61 pages. TR84-002. 1984.

Gary Bishop and Henry Fuchs. 'The Self-Tracker: A Smart Optical Sensor on Silicon'. Proceedings, Conference on Advanced Research in VLSI at MIT (January 23-25, 1984), Artech House 1984, pp. 65-73.



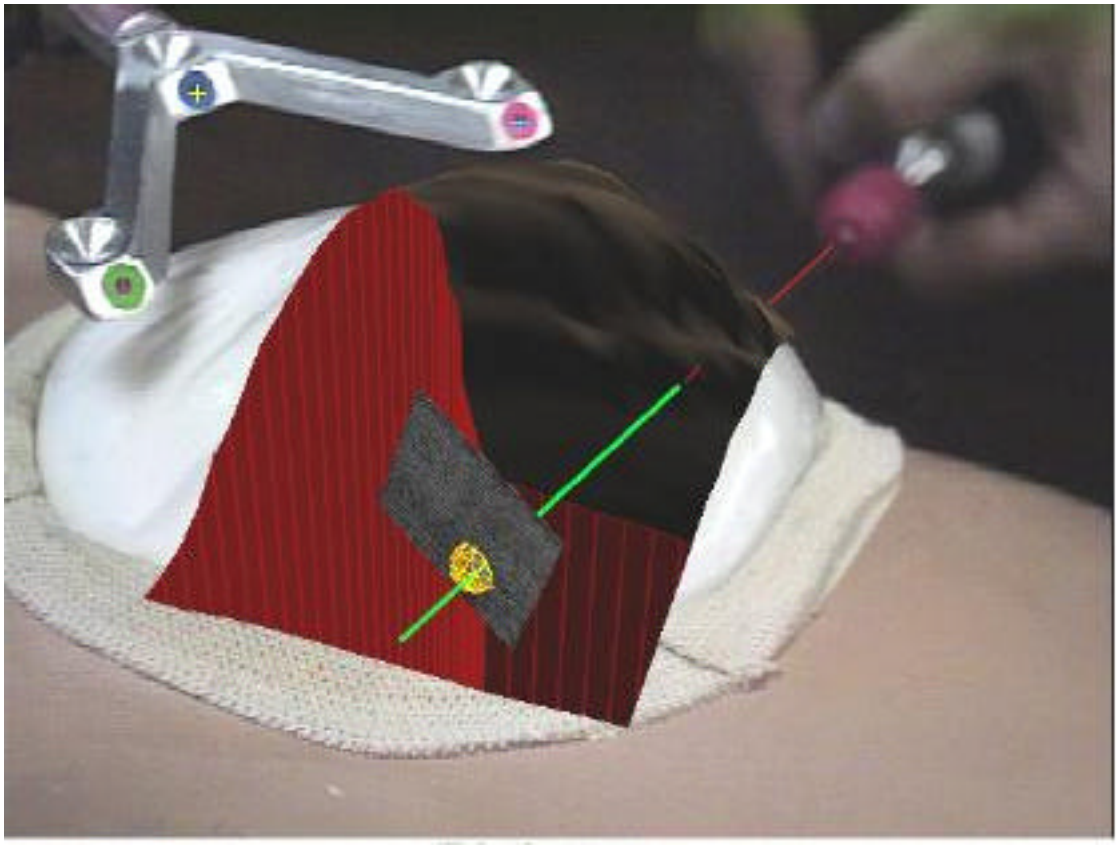
Tracking for AR Systems

Gary Bishop

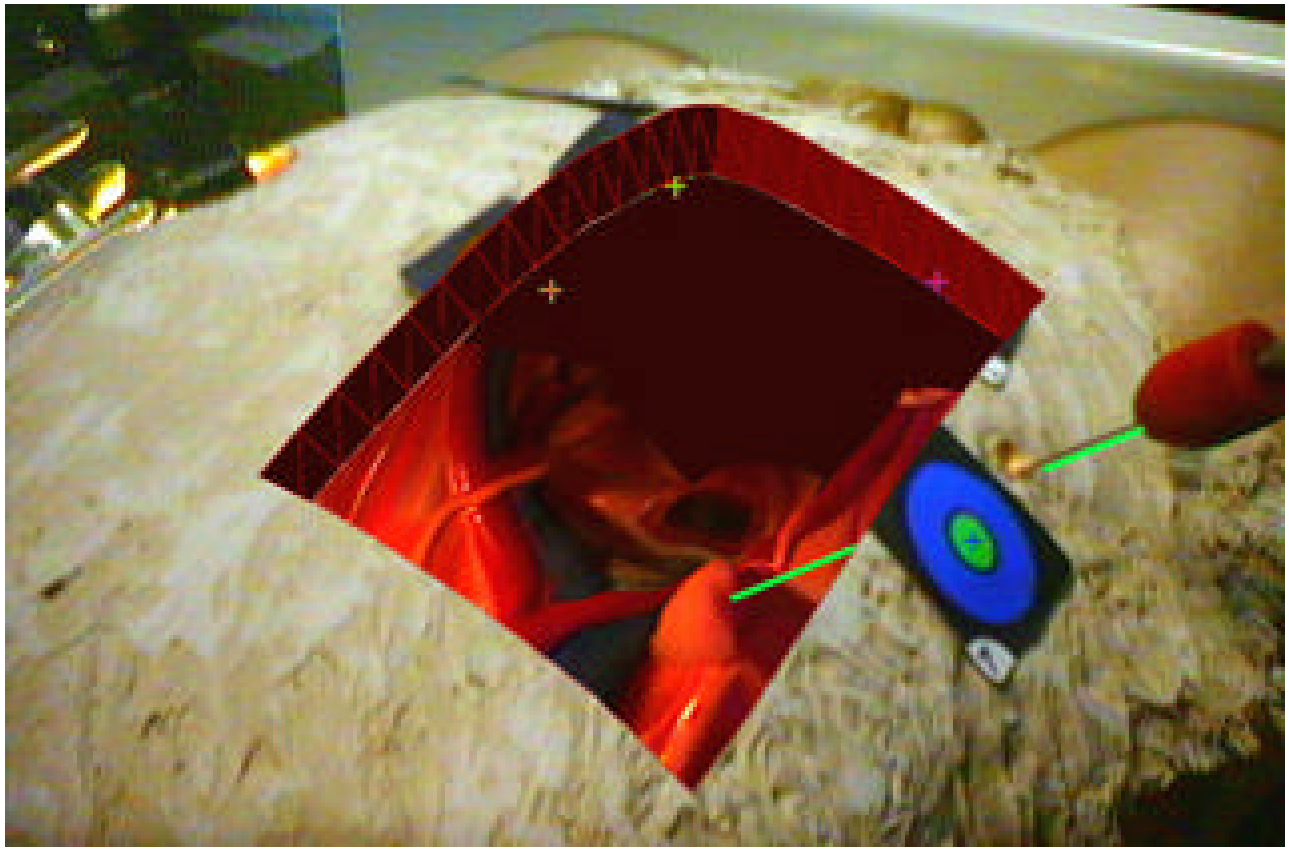
Department of Computer Science

UNC Chapel Hill

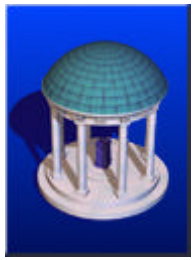
AR for Biopsy

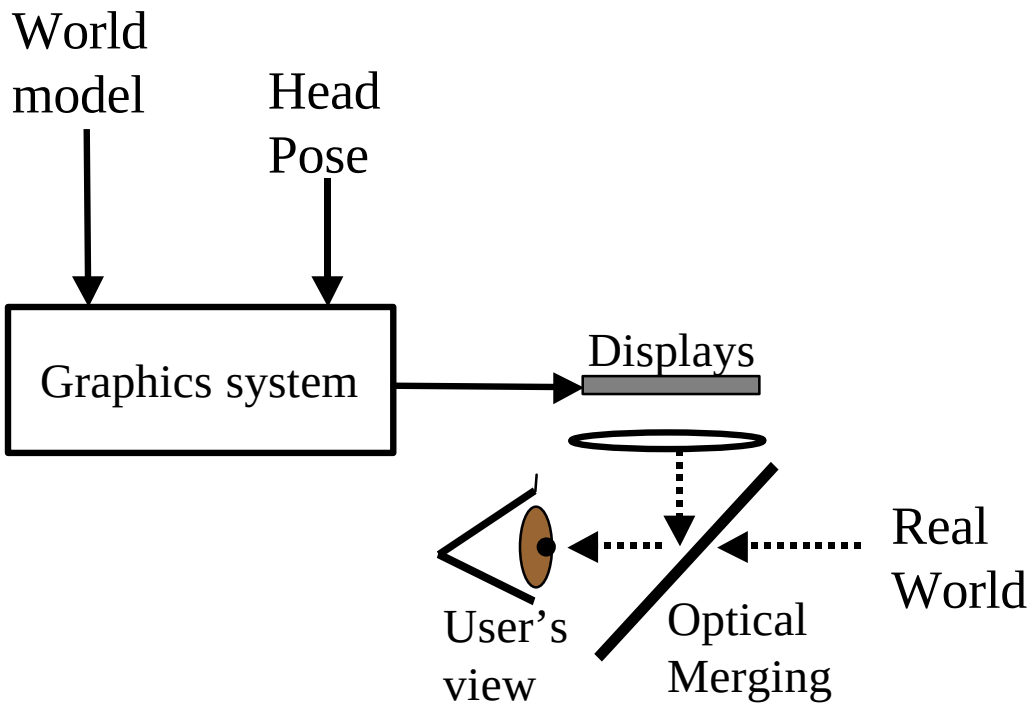


AR for Laparoscopy

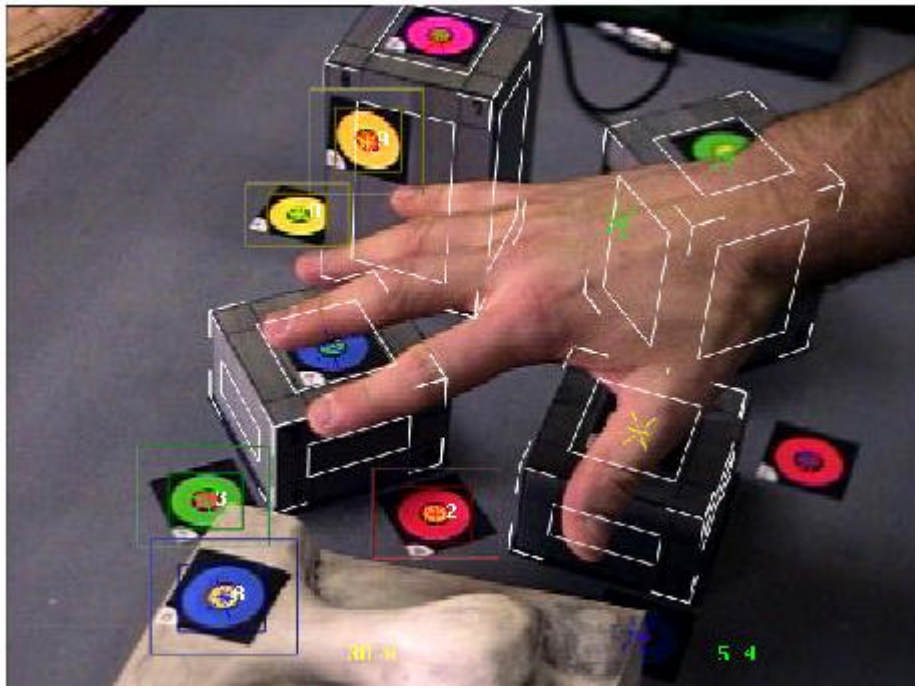


Optical See-Through

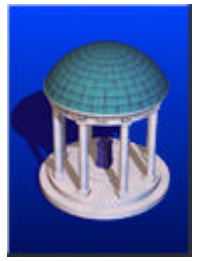


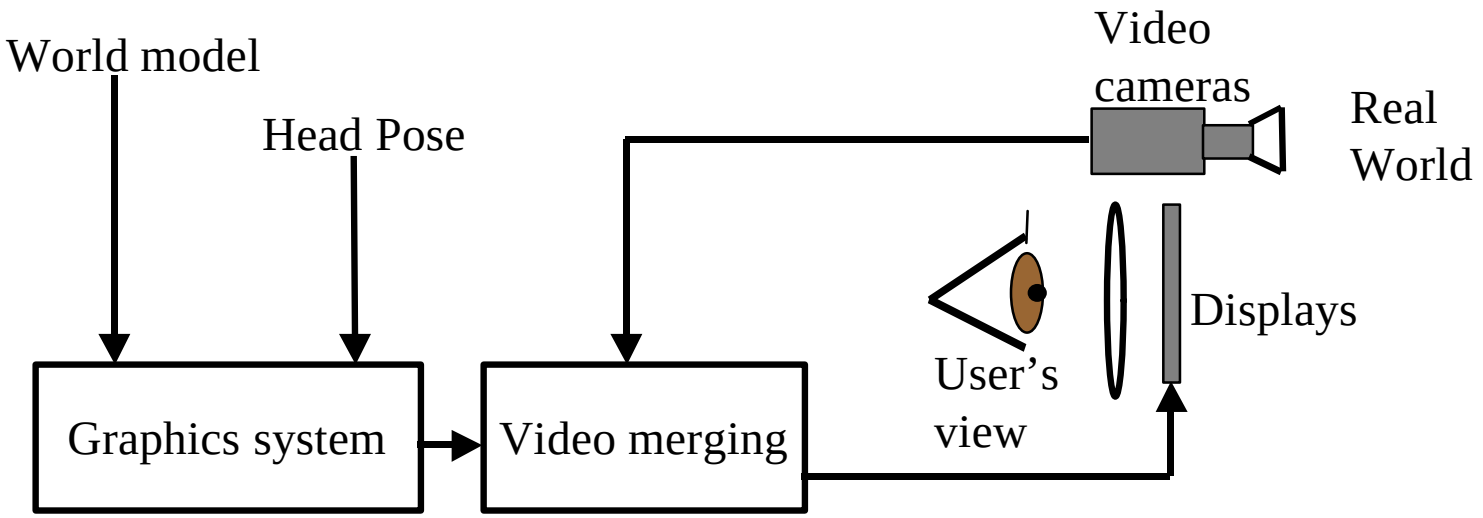


Optical only allows superposition



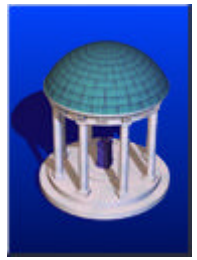
Video See-Through Display

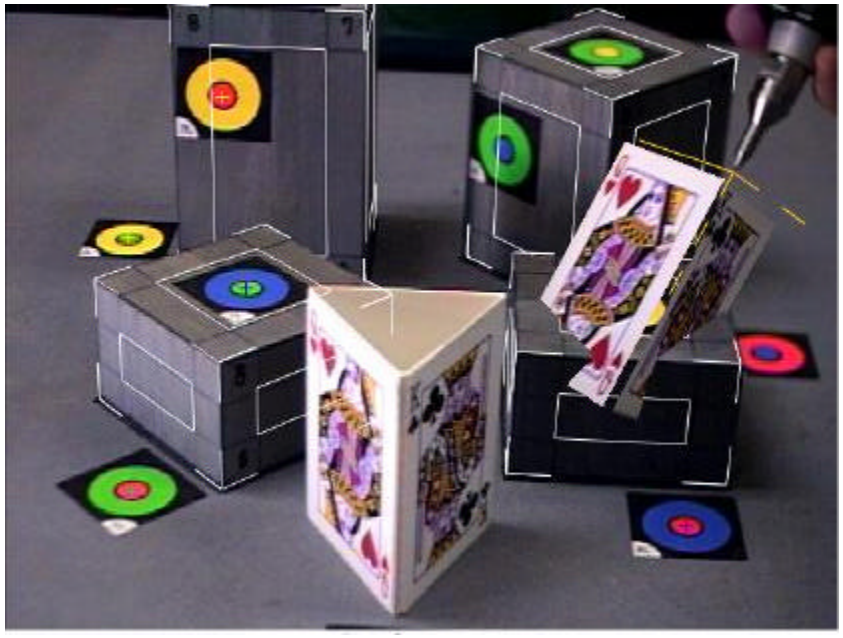




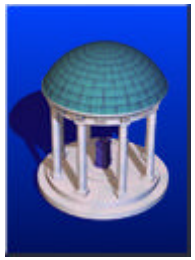
Video See-Through Display

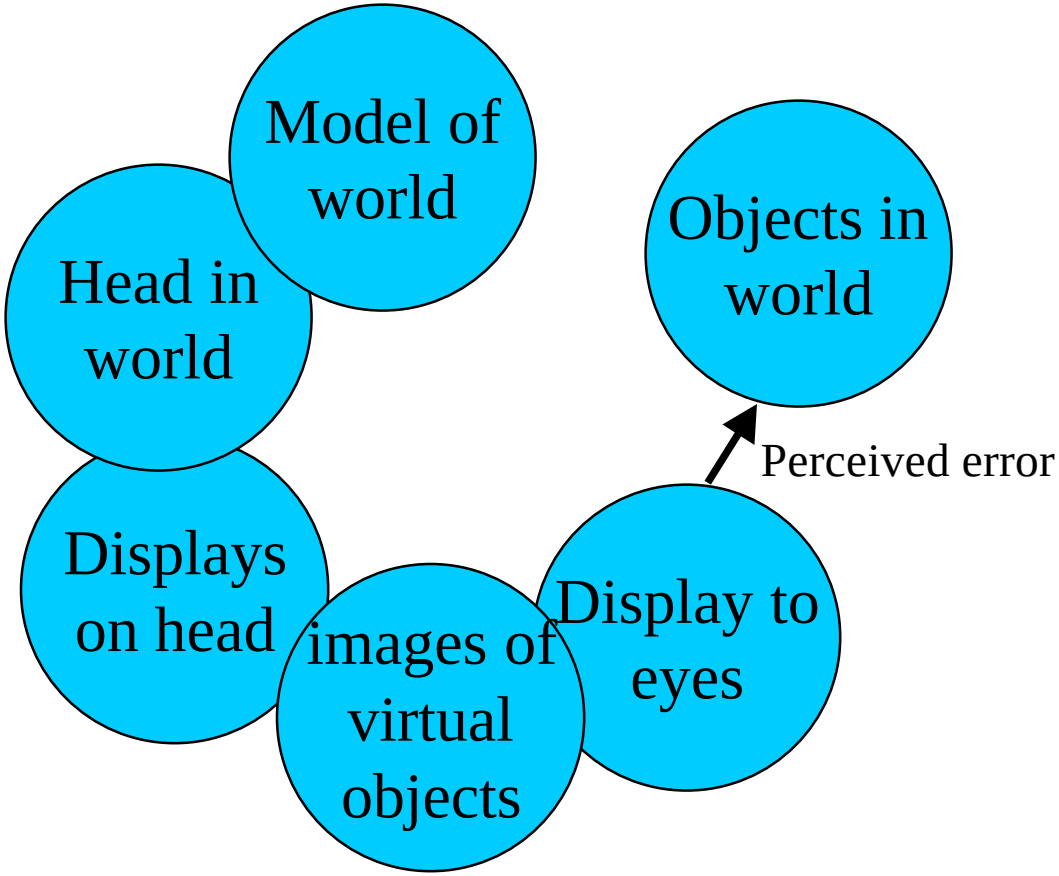
Video allows occlusion



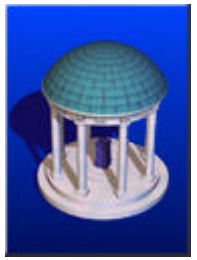


Why is AR so hard?





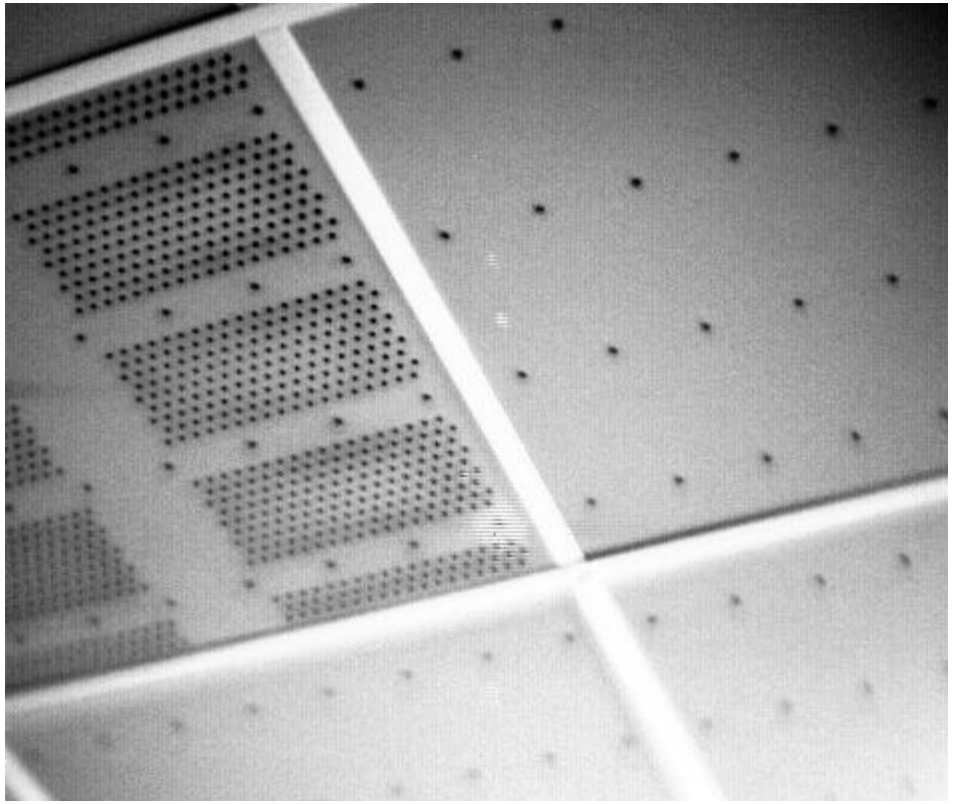
Methods for registration



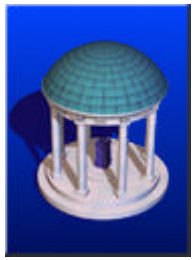
- Open loop
  - get everything right and hope for the best
- Pure video overlay
  - align images without 3D information
- Closed loop with image feedback
  - get close as possible then “lock in” with feedback.

Laboratory Infrastructure

Laboratory Infrastructure

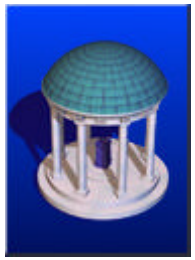


UNC 6DOF GRIDS Effort



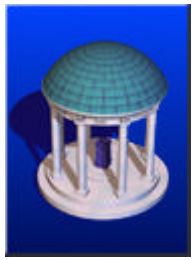
- Orientation and Position tracking
- No reliance on external infrastructure such as beacons, GPS, etc.
- Start with Inertial/Optical hybrid, add other sensing modalities such as active ranging, tilt, etc.

Optical/Inertial Hybrid

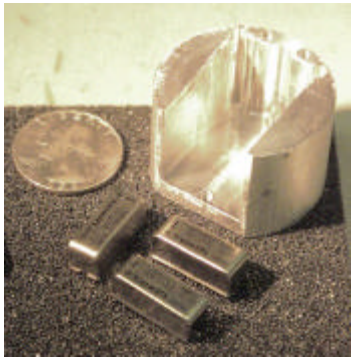


- A fully integrated system
- Inertial aids Optical
  - predictions of how much change to expect
  - where to look, what to reject
- Optical aids Inertial
  - corrects drift
  - allows closing the loop in video see-through

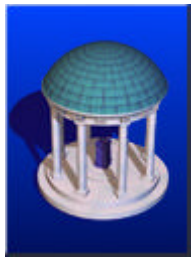
What makes inertial so great?



- Fast
- Passive
- Small
- ***Nearly*** independent of environmental influence



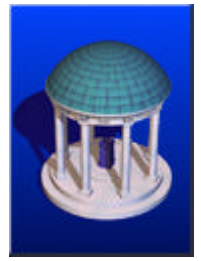
What makes inertial position estimation so hard?

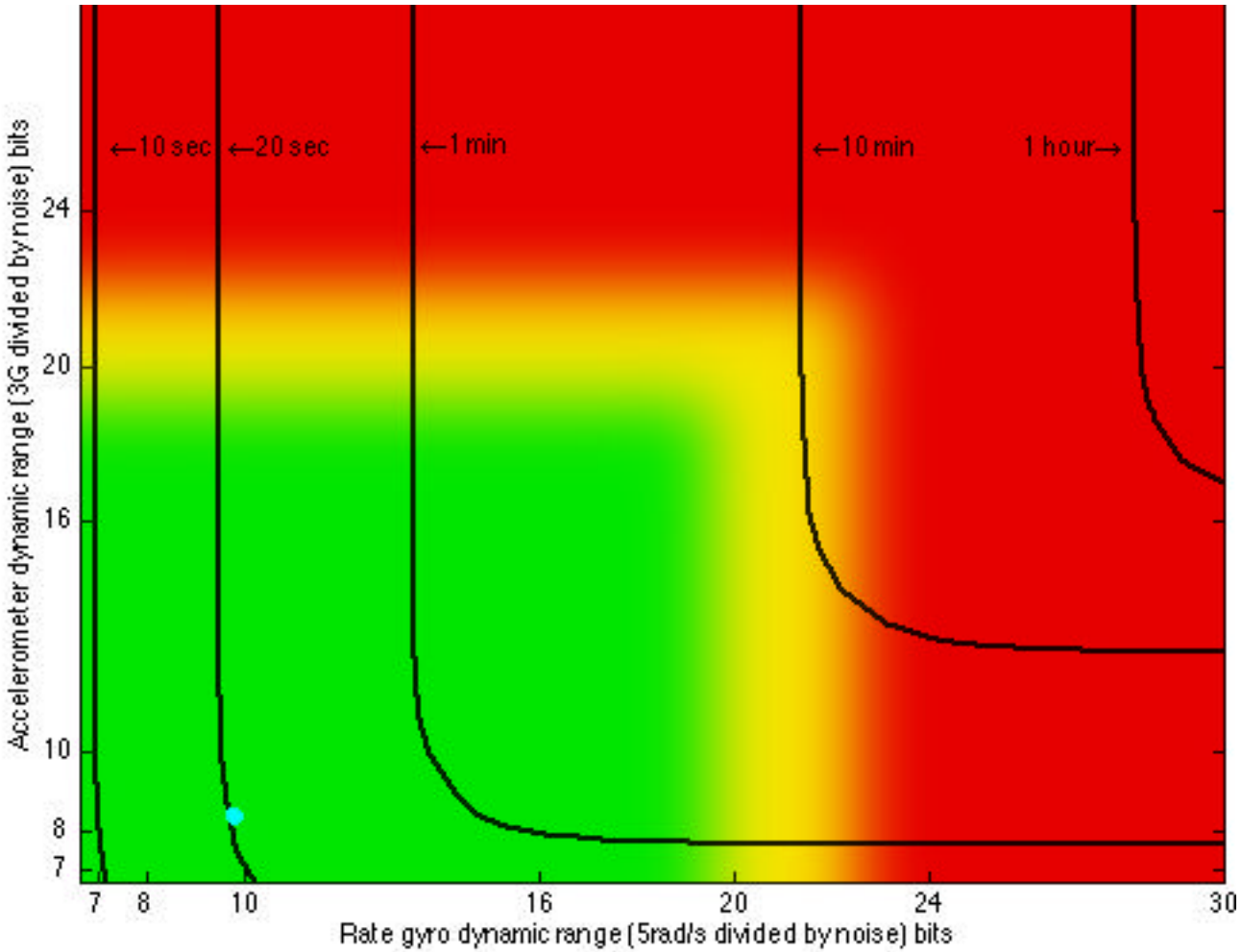


- That *"**Nearly**"*
  - Subtracting out Gravity is the hardest part
  - 1 degree of tilt error over 10 seconds = 9 meters of position error
- Double integration
  - errors accumulate quadratically
  - even unavoidable noise limits system performance

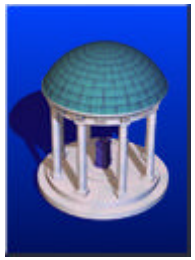
Effect of Inertial Noise

Time to 3 meters uncertainty



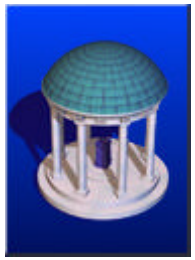


What kind of optical sensors?



- Video is fine for experimentation but …
  - too slow
  - too much computation
  - too much power
- Images are required for display and video see-through but not necessarily for tracking

What kind of optical sensors?



VLSI-based low-power smart optical sensors

not imagers

fast frame rate ⇒

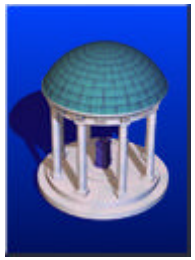
small changes ⇒

simple algorithm ⇒

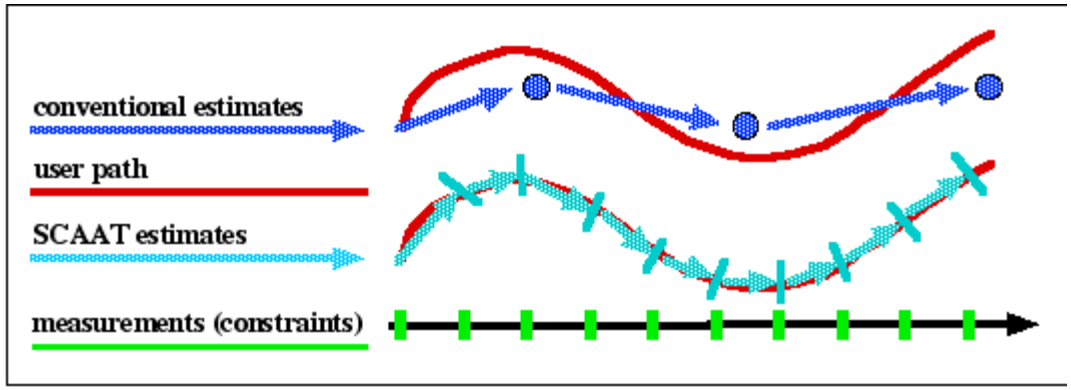
small circuitry ⇒

fast frame rate ⇒

Combining the measurements



SCAAT: Single-Constraint-At-A-Time Tracking



Typically several constraints are collected to compute unique "points" in space. The SCAAT approach blends single constraints to increment along the user's path.